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Impact of Osteoporosis on High-Cost Chronic Diseases

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ABSTRACT

Objective: To assess the impact of osteoporosis on health care costs for patients with chronic disease (CD): cardiovascular disease (CVD), chronic obstructive pulmonary disease (COPD), depression, diabetes mellitus (DM), or two or more of these CDs. **Methods:** This retrospective analysis included commercially insured or Medicare Advantage male and female members aged 50 years or older with medical and pharmacy benefits who had evidence of osteoporosis and/or one of the CDs during the identification period (January 1, 2007, to October 31, 2009). Cohorts were defined by the presence or absence of osteoporosis and CD (osteoporosis ONLY, CD ONLY, and CD plus osteoporosis) and, for osteoporosis cohorts, by incident (recent diagnosis) or prevalent osteoporosis (long-standing). Primary outcome was total health care costs during 1-year follow-up. Costs, adjusted for baseline characteristics, were analyzed with a generalized linear model with log link and gamma distribution. **Results:** Of the 494,160 patients, the majority had evidence of CD with or without

osteoporosis: CVD (54%), two or more CDs (24%), DM (8%), depression (4%), COPD (1%); 9% had osteoporosis ONLY. The range of actual mean costs was as follows: CD ONLY, \$8,377 (CVD) to \$12,801 (two or more CDs); CD plus incident osteoporosis, \$15,696 (CVD) to \$23,860 (two or more CDs); CD plus prevalent osteoporosis, \$10,038 (CVD) to \$17,997 (two or more CDs). Compared with CD ONLY, baseline-adjusted costs were 66% (two or more CDs) to 91% (DM) higher for CD plus incident osteoporosis and 13% (CVD) to 23% (depression) higher for CD plus prevalent osteoporosis ($P < 0.001$). **Conclusions:** The burden of osteoporosis in patients with CD is significant, particularly for patients with newly diagnosed osteoporosis.

Keywords: chronic disease, health care costs, osteoporosis.

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Introduction

Nearly half of the US population has at least one chronic condition, and more than one in four individuals have two or more chronic conditions [1,2]. More than 80% of health care expenditures are attributable to individuals with chronic diseases (CDs) [2]. In 2009, diabetes, heart disease, mental disorders, and pulmonary conditions were among the most costly conditions in the United States: health care expenditures ranged from \$51 billion (diabetes mellitus [DM]) to \$107 billion (heart disease) [3]. Health care costs rise in proportion to comorbidity burden: on average, patients with two chronic conditions incur costs approximately double the costs of patients with one chronic condition [2,4]. The incremental burden of comorbidity poses a substantial challenge to affected individuals and their clinicians [5]. Most clinical guidelines focus on single conditions, and few offer treatment-specific recommendations for comorbid conditions [5,6]. Efforts to manage health care spending will require an increased focus on comorbidities and, in particular, conditions that are preventable [1].

Osteoporosis, a systemic, chronic disease characterized by decrements in bone mass and bone quality, predisposes affected individuals to a higher risk of fracture [7]. Approximately 75% of the individuals diagnosed with osteoporosis are women [8]. The future burden of osteoporosis is heavily dependent on the 34

million men and women who have low bone mass that has not yet progressed to osteoporosis according to diagnostic criteria [9]. The estimated prevalence of osteoporosis in the United States for individuals aged 50 years is 10 million [9], and it is predicted to rise primarily because of changing population demographics [10].

Because the prevalence of osteoporosis increases with age, the population of older individuals is likely to have other chronic conditions [6]. Osteoporosis may exacerbate the CD, and the CD may elevate the risk of fracture. Comorbid heart disease and chronic obstructive pulmonary disease (COPD) are associated with a higher risk of fracture in women with osteoporosis [11]. Inadequate metabolic control of DM may reduce bone density status [12], and standard fracture risk algorithms underestimate the risk in older individuals with type 2 DM [13]. Osteoporosis has been linked to a higher thrombotic risk in patients with coronary artery disease [14], and depressed patients are more prone to falling, increasing the risk of fracture [15]. In these individuals with comorbid disease and osteoporosis, the complexity of their care will likely be increased.

Costs associated with fracture are estimated to rise in the United States from \$19.6 billion (2005) to \$25.2 billion (2025) [16]. These estimates do not include the total burden of osteoporosis-related fractures such as disability, impaired quality of life [17,18], and excess mortality [19]. Estimates of the mean excess costs attributable to osteoporotic fracture are substantial, as high as

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\$28,000, depending on fracture location and other factors [20]. However, studies that estimate the health care cost burden in patients with osteoporosis and common CDs are lacking. The objective of this study was to assess real-world health care expenditures for patients with osteoporosis, alone or in combination with four CDs that are of considerable interest to clinicians and health care payers due to their cost and/or health care resource utilization burden: COPD, cardiovascular disease (CVD) with a chronic component, DM, and depression. Costs were captured by stage of osteoporosis: newly identified (incident) osteoporosis and prevalent. We hypothesized that osteoporosis would add significant costs to the management of patients with comorbid disease.

Methods

Design and Data Source

This retrospective analysis captured eligibility, medical, and pharmacy data from a geographically diverse, national health claims database with the greatest concentration in the South and Midwest census regions. In 2009, this database contained information on approximately 13.3 million individuals with both medical and pharmacy benefits under commercial or Medicare Advantage plans. No identifiable protected health information was extracted or accessed during the course of the study. Pursuant to the Health Insurance Portability and Accountability Act, the use of de-identified data does not require institutional review board approval or waiver [21].

The study spanned two consecutive periods, a 2-year baseline period and a 1-year follow-up period, separated by the index date.

Data from both years of the baseline period were used to establish disease prevalence; data from the second baseline year were used to characterize patients' demographic and clinical characteristics. All data were collected from January 1, 2005, through October 31, 2010.

Patient Identification

The study sample selection, cohorts, and index date assignment are shown in Figure 1; applicable diagnostic codes, procedure codes and medications for the inclusion criteria, and cohort assignment are given in the appendix available in Supplemental Materials found at <http://dx.doi.org/10.1016/j.jval.2013.11.004>. In brief, all patients were commercial or Medicare Advantage enrollees with medical and pharmacy benefits, and had evidence of osteoporosis and/or a CD of interest (COPD, CVD, depression, type 1 or type 2 DM) during the identification (ID) period (January 1, 2007, to October 31, 2009). Inclusion also required continuous enrollment in the health plan with medical and pharmacy benefits for 2 years preindex and 1 year postindex. Patients with evidence of any of the following conditions during the baseline or follow-up period were excluded: Paget's disease of the bone and other osteitis deformans and osteopathies, osteogenesis imperfecta, hypercalcemia, malignant cancer, and human immunodeficiency virus; individuals receiving preventive treatment for breast cancer were also excluded.

Cohort Assignment

Disease-specific algorithms were used to assign patients to cohorts distinguished by the presence or absence of evidence of osteoporosis and the four CDs of interest. The osteoporosis ONLY

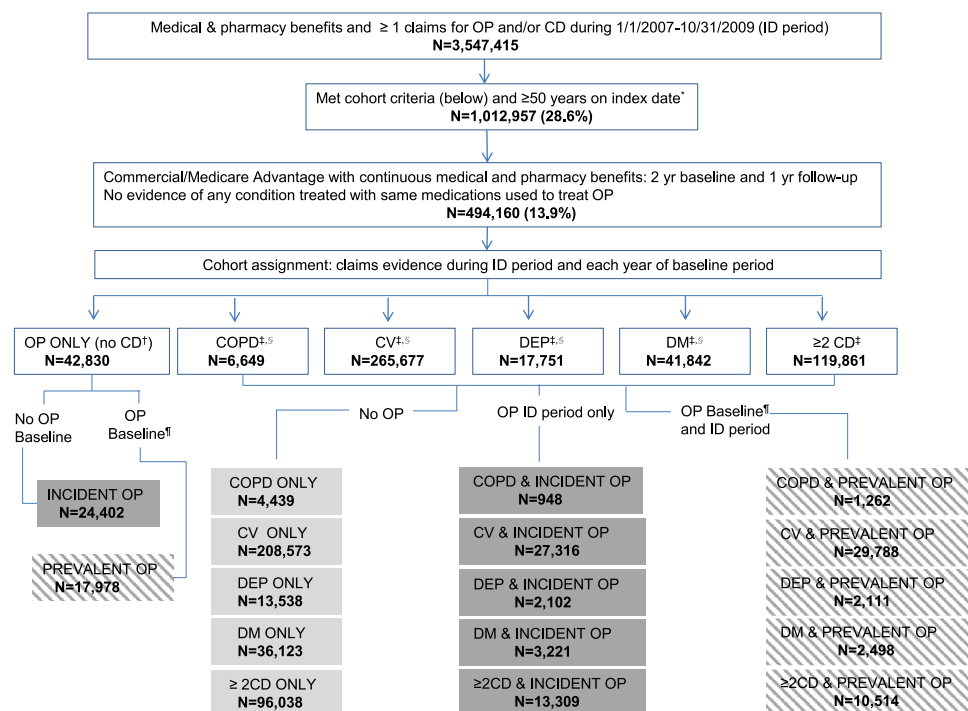


Fig. 1 – Sample selection and cohort assignment. CD, chronic disease; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; DEP, depression; DM, diabetes mellitus; ID, identification; OP, osteoporosis. *Index dates were established during the identification period. Incident OP ONLY and CD plus incident OP: the first date with evidence of OP; prevalent OP ONLY and CD plus prevalent OP: a randomly chosen service date with evidence of OP. CD ONLY: a randomly chosen service date with evidence of CD of interest. †No evidence of CD in the 2-year baseline period. ‡Evidence of CD in both years of the baseline period. §CD cohorts (except two or more CDs) are mutually exclusive of other CD during the baseline period. ¶Evidence of OP in both years of the baseline period.

cohort comprised patients with no evidence of a CD during the 2-year baseline or ID period and at least one claim during the ID period representing one or more of the following: 1) a diagnostic code for osteoporosis (inpatient or outpatient setting), 2) two or more osteoporosis medication claims, and 3) diagnostic or procedure code indicating a closed fracture (inpatient or outpatient setting). The osteoporosis ONLY cohort was further stratified by the presence or absence of osteoporosis in the baseline period. The incident osteoporosis stratum comprised patients with osteoporosis during the ID period but not the 2-year baseline period. The prevalent stratum required evidence of osteoporosis during the ID period and, to ensure long-standing disease, both years of the baseline period.

There were five CD cohorts: COPD, CVD, depression, DM, and two or more of these CDs. Inclusion in the CVD cohort required evidence of a chronic component (cerebrovascular, hypertensive, ischemic, and/or peripheral arterial diseases). The five CD cohorts required the presence of the specific CD(s) during the ID period and, to demonstrate chronicity, both years of the baseline period. The four single CD cohorts were mutually exclusive. For example, patients in the COPD cohort had no evidence of CVD, depression, or DM during either year of the baseline period. The CD cohorts were further categorized by the presence or absence of osteoporosis. The CD ONLY cohort comprised patients with no evidence of osteoporosis during the 2-year baseline or ID period. The CD with osteoporosis cohort was stratified by the presence of incident or prevalent osteoporosis using the same criteria to define incident and prevalent osteoporosis as were used for the osteoporosis ONLY cohort.

Measures

The primary outcome was all-cause total health care costs, computed as the combined health plan and patient-paid amounts, for medical services (ambulatory [physician office and outpatient clinic visits], emergency room visits, inpatient stays, long-term care visits, and other costs) and pharmacy claims. Costs were adjusted by the Consumer Price Index to 2010 dollars [22]. Baseline characteristics, including region of health plan enrollment and patients' demographic and clinical characteristics, were captured in the year before the index date. A modified Quan-Charlson comorbidity score [23] was calculated from medical claims data. This index contains 17 comorbidity categories defined with medical codes and serves as a proxy for burden of comorbidity. Because of the comparison of cohorts with different CDs, the score was modified to exclude comorbidities inherent in the algorithms used to define CDs: CVD, chronic pulmonary disease, DM without and with complication, and peripheral vascular disease. The top Agency for Health Research and Quality comorbidities [24] identified in the sample were also recorded: eye disorders, intervertebral disc disorders and other back problems, nontraumatic joint disorders, other connective tissue disease, respiratory infections, spondylosis, and urinary system diseases. Baseline health care utilization was characterized by the number of ambulatory visits and binary variables for the occurrence of an emergency room visit, inpatient stay, and long-term care visit. For the DM cohort, the type of diabetes (type 1 or type 2) and number of unique medications were also captured.

Statistical Analyses

The effect of osteoporosis within each CD cohort was assessed separately for the incident and prevalent osteoporosis strata. Differences between each CD and osteoporosis versus CD ONLY and between CD and osteoporosis versus osteoporosis ONLY were analyzed by using the t-test (e.g., continuous baseline variables, modified Quan-Charlson comorbidity score, and all-

cause costs during follow-up) and the chi-square test (proportions). Follow-up costs, adjusted for baseline characteristics, were modeled separately by CD and by incident and prevalent osteoporosis strata with a general linear model with log link and gamma distribution. Because of the potential for skewing, adjusted costs were modeled by using Blough's formulation [25]. Baseline adjustment variables were age, sex, region of health plan enrollment, modified Quan-Charlson comorbidity score, health care utilization, Agency for Health Research and Quality binary variables described above, and, for the DM cohort only, type 1 or type 2 DM and count of unique medications. The reference group was the CD ONLY cohort. All analyses were conducted by using SAS 9.1 (SAS, Cary, NC) and Stata version 10.1 (StataCorp, College Station, TX).

Results

Sample Selection and Baseline Characteristics

Of the 3,547,415 patients who met enrollment, age, osteoporosis, and/or CD criteria during the ID period, 494,160 (13.9%) patients met cohort inclusion criteria (Fig. 1). Most of the patients were in the CVD cohort ($N = 265,677$, 54%) followed by multiple CDs ($N = 119,861$, 24%), osteoporosis ($N = 42,380$, 9%), DM ($N = 41,842$, 8%), and depression ($N = 17,751$, 4%). Across cohorts, the mean age was 64 years and 53% of the patients were women (Table 1). Within the CD cohorts, 14% (DM) to 33% (COPD) of the patients also had incident or prevalent osteoporosis. Patients with CD plus incident or prevalent osteoporosis were generally older and had mostly higher comorbidity scores than did patients with CD ONLY or osteoporosis ONLY. There was a pattern for a higher proportion of women in the CD plus osteoporosis cohorts than in the CD ONLY cohorts but a lower proportion of women in the CD plus osteoporosis cohorts than in the osteoporosis ONLY cohort. Across cohorts, most patients had commercial insurance coverage (79.5%). A higher proportion of patients with CD plus osteoporosis were in Medicare Advantage plans compared with CD ONLY or osteoporosis ONLY patients.

Actual Health Care Costs

Total all-cause costs during follow-up, including medical and pharmacy cost components, are shown in Figure 2 by CD cohort and osteoporosis strata. Mean total costs for CD ONLY cohorts ranged from \$8,377 (CVD) to \$12,801 (two or more CDs). For patients with CD with incident osteoporosis, the range in mean costs was \$15,696 (CVD) to \$23,860 (two or more CDs); costs were 1.8 (COPD) to 2.1 (DM) times higher than for patients with CD ONLY ($P < 0.001$, all cohorts). Compared with mean costs for patients with incident osteoporosis ONLY (\$9,330), patients with CD plus incident osteoporosis incurred 1.7 (CVD) to 2.6 (≥ 2 CDs) times higher mean costs ($P < 0.001$, all cohorts). Mean costs for patients with CD plus prevalent osteoporosis ranged from \$10,038 (CVD) to \$17,997 (two or more CDs) and were 20% (CVD) to 47% (depression) higher than for patients with CD ONLY ($P < 0.001$, all cohorts). Mean costs for CD plus prevalent osteoporosis were 1.9 to 3.3 times higher than mean costs for prevalent osteoporosis ONLY (\$5,377) ($P < 0.001$, all cohorts).

Adjusted Health Care Costs

Baseline-adjusted total all-cause costs during follow-up, by CD cohort and osteoporosis strata, are given in Table 2. The cost ratios represent the β coefficient for the modeled results. Adjusted costs based on these models are shown in Figure 3. For the incident osteoporosis stratum, total costs were 66% (two or more CDs) to 91% (DM) higher in the CD plus osteoporosis cohorts than in CD ONLY cohorts ($P < 0.001$, all cohorts). Costs

Table 1 – Baseline patient characteristics by chronic disease cohort and osteoporosis incident and prevalent strata.

Characteristic	OP ONLY	Chronic disease									
		COPD		CVD		DEP		DM		≥2 CDs	
		ONLY	+OP	ONLY	+OP	ONLY	+OP	ONLY	+OP	ONLY	+OP
Incident osteoporosis											
N	24,402	4,439	948	208,573	27,316	13,538	2,102	36,123	3,221	96,038	13,309
Age (y), mean ± SD	58.5 ± 7.4	66.5 ± 10.0	67.9 ± 9.9 ^{*,†}	64.0 ± 10.2	67.9 ± 11.1 ^{*,†}	56.5 ± 6.5	58.2 ± 7.5 [*]	61.3 ± 8.9	64.1 ± 10.2 ^{*,†}	65.0 ± 9.9	68.5 ± 10.5 ^{*,†}
Modified Quan-Charlson score, mean ± SD	0.13 ± 0.45	0.45 ± 0.89	0.46 ± 0.85 [†]	0.39 ± 0.84	0.50 ± 0.94 ^{*,†}	0.19 ± 0.57	0.28 ± 0.71 ^{*,†}	0.26 ± 0.70	0.39 ± 0.85 ^{*,†}	0.61 ± 1.08	0.80 ± 1.22 ^{*,†}
Females, %	82.1	38.9	69.4 ^{*,†}	41.2 [*]	73.4 ^{*,†}	65.9	86.4 ^{*,†}	38.7	70.7 ^{*,†}	40.6	68.9 ^{*,†}
Coverage, %											
Commercial	94.5	67.9	65.9 [‡]	80.7	70.4 ^{*,†}	94.2	90.6 ^{*,†}	88.6	80.5 ^{*,†}	74.9	62.9 ^{*,†}
Medicare Advantage	5.5	32.1	34.1 [‡]	19.4	29.6 ^{*,†}	5.8	9.4 ^{*,†}	11.4	19.5 ^{*,†}	25.1	37.1 ^{*,†}
Region, %											
Northeast	10.8	10.8	11.4	10.6	12.5 ^{*,†}	13.6	14.4 [†]	8.7	10.5 [*]	10.1	11.7 ^{*,‡}
Midwest	24.0	34.1	29.4 ^{†,§}	30.1	28.4 ^{*,†}	33.5	30.3 ^{†,§}	27.8	24.5 [*]	31.3	30.2 ^{†,§}
South	47.5	42.4	44.0 [‡]	47.4	46.9	37.9	40.9 ^{†,§}	48.0	49.5 [‡]	47.8	47.4
West	17.7	12.8	15.2 ^{‡,§}	11.9	12.2 [†]	15.1	14.5 [†]	15.5	15.5 [‡]	10.8	10.6 [†]
Prevalent osteoporosis											
N	17,978	4,439	1,262	208,573	29,788	13,538	2,111	36,123	2,498	96,038	10,514
Age (y), mean ± SD	61.6 ± 7.9	66.5 ± 10.0	70.5 ± 9.8 ^{*,†}	64.0 ± 10.2	71.6 ± 10.4 ^{*,†}	56.5 ± 6.5	61.6 ± 7.9 [*]	61.3 ± 8.9	66.9 ± 10.3 ^{*,†}	65.0 ± 9.9	71.4 ± 10.1 ^{*,†}
Modified Quan-Charlson score	0.16 ± 0.51	0.45 ± 0.89	0.52 ± 0.94 ^{†,§}	0.39 ± 0.84	0.52 ± 0.95 ^{*,†}	0.19 ± 0.57	0.36 ± 0.79 ^{*,†}	0.26 ± 0.70	0.44 ± 0.89 ^{*,†}	0.61 ± 1.08	0.85 ± 1.22 ^{*,†}
Females, %	97.2	38.9	87.8 ^{*,†}	41.2	92.3 ^{*,†}	65.9	95.9 ^{*,†}	38.7	90.4 ^{*,†}	40.6	88.2 ^{*,†}
Coverage, %											
Commercial	93.8	67.9	65.4 [†]	80.7	69.1 ^{*,†}	94.2	87.8 ^{*,†}	88.6	81.5 ^{*,†}	74.9	63.5 ^{*,†}
Medicare Advantage	6.2	32.1	34.6 [†]	19.4	30.9 ^{*,†}	5.8	12.2 ^{*,†}	11.4	18.5 ^{*,†}	25.1	36.5 ^{*,†}
Region, %											
Northeast	9.4	10.8	10.5	10.6	13.9 ^{*,†}	13.6	14.7 [†]	8.7	11.6 ^{*,†}	10.1	14.6 ^{*,†}
Midwest	25.7	34.1	31.1 ^{†,§}	30.1	28.1 ^{*,†}	33.5	28.9 ^{*,‡}	27.8	23.4 ^{*,‡}	31.3	29.1 ^{*,†}
South	45.9	42.4	42.6 [‡]	47.4	43.2 ^{*,†}	37.9	42.3 ^{*,‡}	48.0	46.4	47.8	43.7 ^{*,†}
West	19.0	12.8	15.8 ^{‡,§}	11.9	14.5 ^{*,†}	15.1	14.3 [†]	15.5	18.7 [*]	10.8	12.7 ^{*,†}
CD, chronic disease; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; DEP, depression; DM, diabetes mellitus; OP, osteoporosis.											
* P value for CD + OP vs. CD ONLY < 0.001.											
† P value for CD + OP vs. OP ONLY < 0.001.											
‡ P value for CD + OP vs. OP ONLY < 0.05.											
§ P value for CD + OP vs. CD ONLY < 0.05.											

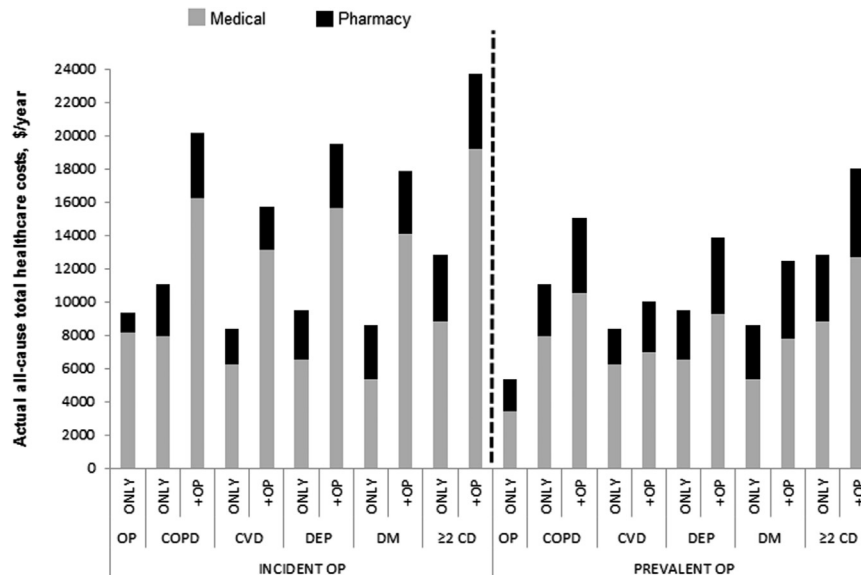


Fig. 2 – Actual all-cause total health care costs by CD cohort and OP incident and prevalent strata during 1-year follow-up. All comparisons of each CD + OP cohort vs. each CD ONLY cohort ($P < 0.001$). All comparisons of each CD + OP cohort vs. OP ONLY cohort ($P < 0.001$). CD, chronic disease; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; DEP, depression; DM, diabetes mellitus; OP, osteoporosis.

were higher for the incident osteoporosis ONLY cohort than for the CD ONLY cohorts for CVD (32%, $P < 0.001$), depression (31%, $P < 0.001$), and DM (66%, $P < 0.001$) but 5% lower than the two or more CDs ONLY cohort ($P < 0.001$). There was no difference in costs between CD ONLY and incident osteoporosis ONLY for the COPD cohort ($P = 0.80$). In the prevalent osteoporosis stratum, cohorts with CD plus osteoporosis had 13% to 23% higher costs than the CD ONLY cohorts ($P < 0.001$). The opposite pattern was evident for the prevalent osteoporosis ONLY cohort: costs were lower than for each CD ONLY cohort by 11% (DM ONLY) to 43% (two or more CDs ONLY) ($P < 0.001$).

Discussion

The results of this study reveal the substantial burden of osteoporosis in patients with four common CDs that are of significant interest to payers. For patients with one or more of these comorbidities, concomitant osteoporosis increased adjusted costs by 66% to 91% in the incident stratum and by 13% to 23% in the prevalent stratum compared with costs of the CD(s) alone. The burden of osteoporosis was highest in patients with two or more CDs. These findings highlight the need to aggressively manage osteoporosis to minimize additional burden for patients who already incur high health care costs. Disease management programs based on enhanced education, screening, and treatment of patients with osteoporosis, or at risk of developing osteoporosis, have been demonstrated to reduce fracture rates, and the costs of these programs were more than offset by predicted cost savings associated with the reduction in fractures [26,27]. Because fracture risk may be elevated in some CDs [11,12,15], proactive management of osteoporosis under these conditions will be particularly important to contain costs.

The higher costs of incident osteoporosis compared with those of prevalent osteoporosis are noteworthy. Our primary comparisons were for the effect of osteoporosis alone or in combination with a CD within each osteoporosis stratum and we did not make formal comparisons between the incident and

prevalent strata. Nevertheless, these results suggest that the burden of osteoporosis is larger in newly diagnosed patients with existing CD. This may be attributable to a combination of factors. Clinical management of osteoporosis in the context of comorbid conditions may be more complex. The initial diagnosis of osteoporosis is likely to require additional resource utilization for bone density screening and ambulatory visits that would not likely occur or occur as frequently for patients who have already been diagnosed with osteoporosis. Furthermore, the diagnosis of osteoporosis may occur in conjunction with or as a result of a fragility fracture. Excess costs attributable to nonvertebral fracture in the first year have been estimated at \$5,267, ranging from \$2,607 to \$13,334 depending on fracture location [28]. One of the qualifying criteria for inclusion in an osteoporosis cohort in this study was a fracture on or after the index date. For patients with osteoporosis only, a fracture on the index date was the qualifying event for 34% of the incident group and 7% of the prevalent group. Excess costs attributable to fragility fracture are potentially avoidable because effective treatments are available [29].

For patients with a chronic condition and no evidence of osteoporosis, actual total annual health care costs ranged from \$8,377 to \$12,801. As expected, patients with multiple CDs incurred the highest costs (\$12,801), followed by patients with COPD (\$11,048), depression (\$9,467), DM (\$8,570), and CVD (\$8,377), respectively. These values are lower than recent estimates from other research: COPD, \$17,765 to \$23,492 [4,30,31]; depression, \$10,024 to \$17,990 [4,32]; DM, \$11,744 [33]. For CVD, we included several conditions with chronic components and our costs cannot be readily compared with studies focused on a single condition. Our results for COPD, depression, and DM may be lower because we included only patients with prevalent, stable chronic disease, thus excluding recently diagnosed patients who may incur higher costs around the time of diagnosis. Furthermore, lower mean costs for our single CD cohorts would be expected because each cohort is mutually exclusive and the conditions we examined may cluster [34,35].

This study provides a fuller understanding of the real-world health care costs associated with osteoporosis in the context of preexisting comorbidity and addresses a significant gap in the

Table 2 – Adjusted cost ratios during 1-y follow-up by chronic disease and osteoporosis incident and prevalent strata.

Reference group: CD ONLY	Chronic disease									
	COPD*		CVD†		DEP‡		DM§		≥ 2 CD¶	
	Cost ratio (95% CI)	P	Cost ratio (95% CI)	P	Cost ratio (95% CI)	P	Cost ratio (95% CI)	P	Cost ratio (95% CI)	P
<i>Incident osteoporosis</i>										
CD + OP	1.77 (1.54–2.05)	<0.001	1.71 (1.67–1.75)	<0.001	1.76 (1.61–1.91)	<0.001	1.91 (1.78–2.05)	<0.001	1.66 (1.61–1.72)	<0.001
OP ONLY	1.01 (0.94–1.09)	0.80	1.32 (1.28–1.35)	<0.001	1.31 (1.26–1.37)	<0.001	1.66 (1.60–1.73)	<0.001	0.95 (0.92–0.97)	<0.001
<i>Prevalent osteoporosis</i>										
CD + OP	1.20 (1.09–1.33)	<0.001	1.13 (1.10–1.15)	<0.001	1.23 (1.16–1.32)	<0.001	1.19 (1.11–1.27)	<0.001	1.19 (1.15–1.23)	<0.001
OP ONLY	0.58 (0.54–0.62)	<0.001	0.79 (0.77–0.82)	<0.001	0.79 (0.77–0.82)	<0.001	0.89 (0.85–0.92)	<0.001	0.57 (0.56–0.59)	<0.001

AHRQ, Agency for Healthcare Research and Quality; CD, chronic disease; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; DEP, depression; DM, diabetes mellitus; OP, osteoporosis.

* COPD: Male gender, higher comorbidity score, nontraumatic joint disorders (prevalent stratum only), other connective tissue disease (incident OP stratum only), spondylosis and other back problems, occurrence of an inpatient (IP) stay, emergency room (ER) visit (prevalent OP stratum only), and more ambulatory visits were associated with higher cost ratios.

† CVD: Male gender, higher comorbidity score, AHRQ comorbidities except eye disorders, occurrence of an IP stay, ER visit, long-term care visit, and more ambulatory visits were associated with higher cost ratios.

‡ DEP: Male gender, higher comorbidity score, nontraumatic joint disorders and other connective tissue disease, spondylosis and other back problems, eye disorders (prevalent OP stratum only), respiratory infections (prevalent OP stratum only), diseases of the urinary system (prevalent OP stratum only), occurrence of an IP stay, ER visit, long-term care visit (incident OP stratum only), and more ambulatory visits were associated with higher cost ratios.

§ DM: Male gender, type 1 DM, midwest region (incident OP stratum only), higher comorbidity score, nontraumatic joint disorders, diseases of the urinary system (prevalent OP stratum only), spondylosis and other back problems (incident OP stratum only), occurrence of an IP stay, ER visit, long-term care visit, and more ambulatory visits were associated with higher cost ratios.

¶ ≥ 2 CDs: Male gender, higher comorbidity score, AHRQ comorbidities except eye disorders, occurrence of an IP stay, ER visit, long-term care visit, and more ambulatory visits were associated with higher cost ratios.

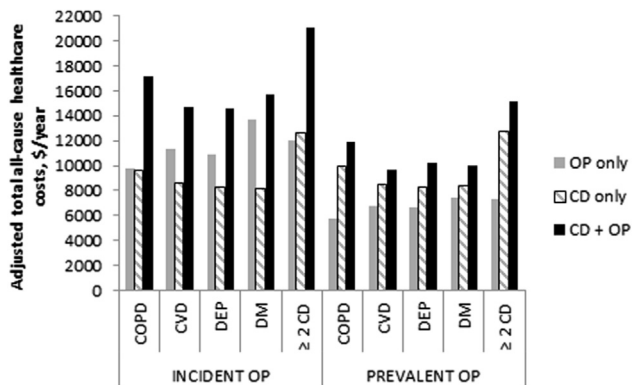


Fig. 3 – Adjusted all-cause total health care costs by CD cohort and OP incident and prevalent strata during 1-year follow-up. All comparisons of each CD + OP cohort vs. each CD ONLY cohort (reference group) ($P < 0.001$). CD, chronic disease; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; DEP, depression; DM, diabetes; OP, osteoporosis.

literature. The management of osteoporosis in conjunction with other comorbidity is resource intensive and adds significant burden to patients, their providers, and health care systems. Additional research, particularly studies of other prevalent and costly chronic conditions and in patients with higher comorbidity, is warranted to extend our findings.

The results of this study should be interpreted in light of important limitations. Our study is based on administrative claims data; we used medical and procedures codes in conjunction with pharmacy claims to identify the study cohorts. A diagnostic code on a medical claim is not proof positive of a disease, and diagnostic codes may be missing. We used closed fracture codes as one of the inclusion criteria for patients with osteoporosis, and it is possible that some of the fractures were not directly related to osteoporosis. A pharmacy claim does not guarantee that a medication was taken or taken as prescribed. Furthermore, patients included in the osteoporosis cohort based only on pharmacy claims may have been prescribed the medication for osteoporosis prevention. There were significant imbalances in patients' baseline demographic and clinical characteristics. Our health care costs are based on multivariate adjustment for baseline differences but may not have fully accounted for these differences and/or there may have been other differences that we could not observe in our database. Our results are based on a sample of patients with commercial and Medicare Advantage coverage. Patients with Medicare Advantage may not be representative of the Medicare population. Furthermore, our sample included only patients with continuous health plan enrollment for at least 36 months. Thus, our results are primarily applicable to patterns of CD and osteoporosis in stable, managed care settings.

Conclusions

Osteoporosis, particularly newly identified osteoporosis, is associated with considerable health care cost and a significantly higher burden for patients with COPD, CVD, depression, and/or DM. Costs were highest for patients with two or more of these conditions. Results from this study suggest that in patients who are already being treated for CDs with high cost and/or high health care resource utilization, osteoporosis can add a significant cost burden. In these patients, appropriate treatment and management of osteoporosis in conjunction with the patients'

CDs should be prioritized to improve the overall quality of care and potentially reduce total health care costs.

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Supplemental Materials

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